FLIGHT TELEMETRY

instruction manual

MODEL 5310 BR

EPUT® METER

INSTRUMENT SERVICE LOAN POOL

Beckman® / *Berkeley Division*

INSTRUCTION MANUAL

MODEL 5310 BR

EPUT® METER

Serial Prefix 12-

Ser. No. - 200

NOTE

If model number is followed by one or more letters, the instrument covered by this manual has been modified. See section on modifications.

INSTRUMENT SERVICE LOAN POOL

Beckman/Berkeley Division
Richmond, California

December 1961

WARRANTY

Instruments sold by Berkeley Division, Beckman Instruments, Inc., (hereafter called "the Company") are warranted only as stated below.

Subject to the exceptions and upon the conditions specified below, the Company agrees to correct, either by repair, or, at its election, by replacement, any defect of material or workmanship which develops within one year after delivery of the instrument to the original purchaser by the Company or by an authorized representative, provided that investigation and factory inspection by the Company discloses that such defect developed under normal and proper use.

The exceptions and conditions mentioned above are the following:

(a) Some components and accessories by their nature are not intended to, and will not, function one year. If any such component or accessory manufactured by the Company and part of the item sold fails to give reasonable service for a reasonable period of time, the Company will, at its election, replace or repair such component or accessory. What constitutes reasonable service and what constitutes a reasonable period of time shall be determined solely by the Company after the Company is in posession of all the facts concerning operating conditions and other pertinent factors and after such component or accessory has been returned to the Company, transportation prepaid.

(b) All instruments claimed defective must be returned to the Company, transportation charges prepaid, and will be returned to the customer with the transportation charges collect, unless the item is found to be defective in which case the Company will pay all transportation charges.

(c) The Company makes no warranty concerning components or accessories not manufactured by it, such as tubes, fuses, batteries, etc. However, in the event of the failure of any component or accessory not manufactured by the Company, the Company will give reasonable assistance to the purchaser in obtaining from the respective manufacturer whatever adjustment is reasonable in the light of the manufacturer's own warranty.

(d) Except as stated above, the Company makes no warranty, express or implied (either in fact or by operation of law), statutory or otherwise; and, except to the extent stated above, the Company shall have no liability under any warranty, express or implied (either in fact or by operation of law), statutory or otherwise.

(e) The Company expressly disclaims any liability to its customers, dealers, and to users of its products, and to any other person or persons for consequential damages of any kind and from any cause whatsoever arising out of or in any way connected with the manufacture, sale, repair, replacement of, or arising out of or in any way connected with the use of any of its products.

(f) Representations and warranties made by any person, including representatives of the Company, which are inconsistent or in conflict with the terms of this warranty (including but not limited to the limitation of the liability of the Company as set forth above) shall not be binding upon the Company unless reduced to writing and approved by an officer of the Company.

(g) This warranty shall be governed by the laws of the State of California.

Claims for damage in shipment should be filed promptly with the transportation company.

All correspondence concerning the instrument should specify the model and serial number. This information appears on the company name plate. Any inquiry concerning details of operation, possible modifications, etc., should be addressed to the Sales Department, Berkeley division of Beckman Instruments, Inc., Richmond 4, California.

REPAIR SERVICE

Experienced service personnel and special test equipment are available at the factory to perform any necessary repairs. Every effort will be made to expedite the repair of instruments returned for servicing. Repair work will be performed only upon receipt of a written purchase order or authorization. Instruments to be repaired should be addressed to SERVICE AND REPAIR DEPARTMENT with transportation charges prepaid. Repaired instruments will be returned to the purchaser with transportation charges collect.

Berkeley reserves the right to make changes in design at any time without incurring any obligation to modify equipment previously purchased to conform to subsequent design changes.

BERKELEY DIVISION
BECKMAN INSTRUMENTS, INC.

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MODIFICATIONS

DIAGRAMS

Figure 4 Operating Controls and Indicators
Model 5310 Block Diagram (C 404599)
Master Schematic Diagram (D 404597)
Input Amplifier, Schematic Diagram (C 404598)
Time Base Generator, Schematic Diagram (D 404600)
Counting Circuit, Schematic Diagram (D 404601)
Power Supply, Schematic Diagram (C 401061)

APPENDICES

Instruction Manual for Model 750A DCU
Instruction Manual for Model 751A DCI

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1. INTRODUCTION

1.1 GENERAL DESCRIPTION

The Model 5310 EPUT® Meter is a lightweight electronic counter that will measure the number of events occurring in a unit of time, or measure the time between recurring events. That is, it measures frequency and period.

Made up almost entirely of printed-circuit, plug-in modules and using solid-state components throughout, the instrument consumes little power and is easy to service.

As shown in Figure 1, the main functional elements are an Input Circuit, a Time Base Generator, a Count Gate, Gate Control Circuits, and a chain of Decimal Counting Units (DCU's). The Input Circuit converts input signals into pulses of the size and shape needed by the gating logic. The Time Base Generator produces similar pulses (called "clock pulses") at precise, decimal intervals of one second through ten microseconds, selected by the TIME-SECONDS selector. According to the mode of operation set by the FUNCTION selector, either input pulses or clock pulses open and close the Count Gate. When the Count Gate is open, pulses pass through it to the DCU's, which present the total both visually as lighted decimal digits and electrically as binary-coded readout signals.

A RESET button and a DISPLAY control allow the operator to reset the counter manually or automatically; and a built-in test feature lets him check the instrument for proper operation at any time.

1. 2 TECHNICAL CHARACTERISTICS

Input Frequency Range

10 cps to 200 kc

Maximum Input Sensitivity

0.1 v rms (0.3 v peak-to-peak)

Paired Pulse Resolution

3 microseconds

Count Capacity

99, 999

Time Base Interval

From 1 second to 10^{-5} seconds, selected in decade steps.

Counting Accuracy

±1 count ± accuracy of crystal oscillator.

Oscillator Stability

Depends on crystal used. Unheated crystal supplied with standard Model 5310 has the following characteristics.

Frequency stability: 3 parts in 10^7 per 24 hour period (at 25°C.)

Frequency deviation with temperature: ±1 part in 10^5 for ±10 degree deviation from 25 degrees C.

For characteristics of other crystals available, see MODIFICATIONS section.

Display Time

Continuously variable from 0.1 sec. to approximately 10 sec. Display can also be maintained indefinitely.

Ambient Temperature Range

-20 to +65 degrees C. (-4 to +150 degrees F.)

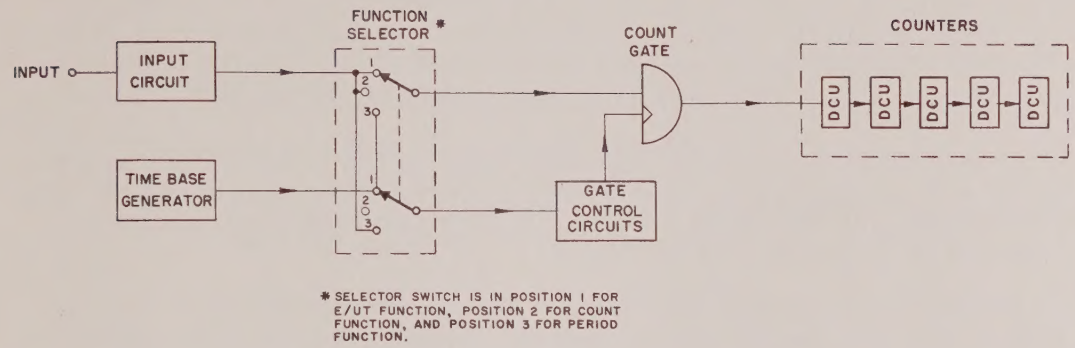


FIG. 1. This simplified block diagram of the Model 5310 shows how the major functional elements are interconnected.

Power Required

40 watts. Operates from 117 v (±10%), 50 to 400 cps AC source (with transformer taps provided for nominal 105 v, and 126 v).

Dimensions

With cabinet: 7 1/4 in. high, 21 in. wide, 15 in. deep

Without cabinet: 5 1/4 in. high, 19 in. wide, 12 in. deep

Weight

25 lb (with cabinet)

1.3 APPLICATIONS

The Model 5310 EPUT® Meter is useful for all counting, timing, and frequency measuring operations in which reliability and portability are important factors. Careful design and rugged construction make this instrument especially suitable for industrial and field testing applications. When equipped with a built-in battery power supply, the unit will operate even where no external source of power is available.

2. OPERATION

2.1 INSTALLING AND ENERGIZING THE INSTRUMENT

The instrument is ready for use as it arrives from the factory and will operate in any environment tolerable to personnel. Moreover, the unit can be operated inside its cabinet, or removed from the cabinet and mounted in a standard 19 inch rack.

To energize the instrument, connect the power cord to a 117 volt AC source and turn the POWER switch on. Although no warm-up period is required, it is advisable to allow about 30 seconds for the circuits to stabilize before operation is begun. (NOTE: For warm-up time needed with a heated crystal, see "Modification D" in section on modifications.)

2.2 OPERATING CONTROLS AND INDICATORS

The operating controls and indicators on the instrument (see Fig. 4) have the following functions:

FUNCTION Selector. Selects the mode of operation (see sections 2.3 and 2.5 through 2.7 for a description of each mode).

TIME-SECONDS Selector. Selects the time base interval for all modes of operation except COUNT. Determines the counting period in E/UT and TEST operation, or the time unit in which PERIOD is measured.

INPUT Jack. The front panel connector through which the signal being measured is fed to the instrument.

SENSITIVITY Control. Continuously varies the input sensitivity of the instrument by attenuating the signal coming through the INPUT jack. (See section 2.4, "Input Requirements and Adjustments".)

Count Indicators. Display the number of counts registered by the instrument. In E/UT operation, the indicators show the number of events which are occurring during the interval for which the TIME-SECONDS Selector is set. In PERIOD operation, the indicators display the number of time units elapsed between successive events.

DISPLAY Control. Determines how long the instrument will hold a reading before resetting and beginning another count. Continuously varies the display time from 0.1 second to approximately 10 seconds. When the control is switched into its "infinity" position, the instrument will hold a reading until the operator presses the RESET button.

RESET Button. Resets the count indicators to zero and clears the instrument for the next counting period.

2.3 TESTING FOR PROPER OPERATION

With the built-in test feature, a quick check can be made to see if the instrument is functioning properly. This should be done routinely just before actual operation is begun, and periodically during extended periods of operation.

To perform a test, proceed as follows:

1) Rotate the DISPLAY control to a point near the extreme counter-clockwise position to produce a short display time.

2) Set the FUNCTION selector at TEST.

3) Rotate the TIME-SECONDS selector through each of its settings beginning with "10-5", and note the indicated count obtained at each position. If the instrument is functioning properly, the readings will be as listed in Table I.

Table I. Test Indications

TIME-SECONDS SETTING	CORRECT COUNT INDICATIONS
10^{-5}	00001
10^{-4}	00010 (+1 count)
10^{-3}	00100 (+1 count)
10^{-2}	01000 (+1 count)
10^{-1}	10000 (+1 count)
1	00000 (+1 count)

2.4 INPUT REQUIREMENTS AND ADJUSTMENTS

The input signal to the instrument must have an amplitude of at least 0.1 volt rms (0.3 volt peak-to-peak) and a frequency within the range of 10 cps to 200 kc. Signals with amplitudes up to 400 volts peak-to-ground can safely be used. The impedance between the INPUT

connector and chassis ground is 0.1 megohm with a shunt capacitance of 5$\mu\mu$f.

The SENSITIVITY control attenuates the signal applied to the INPUT connector. Starting in the extreme counterclockwise position, the control should be rotated slowly clockwise to a point just beyond where the instrument begins to count reliably.

2.5 MEASURING EVENTS PER UNIT TIME

2.5.1 Description of the E/UT Mode. (Refer to Fig. 1). In this mode of operation, the unit counts pulses derived from the signal at the INPUT connector during the time that the Count Gate is open. The Count Gate is opened and closed by successive clock pulses from the Time Base Generator. Thus, the counting period is equal to the time interval between clock pulses which, in turn, is determined by the setting of the TIME-SECONDS selector.

2.5.2 Operating Procedure. To measure events per unit time, proceed as follows:

1) Couple the signal being measured to the INPUT connector (see section 2.4 for input signal requirements).

2) Set the FUNCTION selector at E/UT.

3) Set the TIME-SECONDS selector for the time interval over which counting is to take place. (NOTE: If the frequency of the signal being measured is higher than 100 kc and the reading must include the most significant figure, the longest time interval which can be used is 10^{-1} seconds.)

4) Adjust the SENSITIVITY control as described in section 2.4.

5) Adjust the DISPLAY control so that the count is displayed for a convenient length of time. If each reading is to be displayed until the instrument is manually reset, turn the DISPLAY control into its "infinity" position (as indicated by a switch click).

6) Read the count displayed by the digital indicators. If the TIME-SECONDS selector is set at "1", the reading gives the number of events per second directly. If the TIME-SECONDS selector is at a setting other than "1", divide the reading by the TIME-SECONDS setting to obtain events per second.

2.6 MEASURING A PERIOD

2.6.1 Description of the PER(iod) Mode. (Refer to Fig. 1.) In this mode, the unit counts the number of clock pulses from its Time Base Generator which go through the Count Gate while it is open. The gate, in this case, is controlled by the signal at the INPUT jack, and is alternately opened and closed each time that signal passes through a certain voltage level. Since the clock pulses mark certain precise intervals of time, the count indicated by the instrument represents the elapsed time during which the gate was open. Consequently, this is the period of the recurring events represented by voltage changes at the input connector.

2.6.2 Operating Procedure. To make a period measurement, proceed as follows:

1) Couple the signal being measured to the INPUT connector (see section 2.4 for input signal requirements).

2) Set the FUNCTION selector at PER.

3) Set the TIME-SECONDS selector for the time unit in which the period is to be measured. For example, with the selector at "10^{-4}", the period is measured in units of .0001 second. The smaller the time unit chosen, the more accurate the readings.

4) Adjust the SENSITIVITY control as described in section 2.4.

5) Adjust the DISPLAY control so that the count is displayed for a convenient length of time. If each reading is to be displayed until the instrument is manually reset, turn the DISPLAY control into its "infinity" position (as indicated by a switch click).

6) Read the count displayed by the digital indicators. To obtain the length of the period in seconds, multiply the reading by the TIME-SECONDS setting.

2.7 COUNTING EVENTS

2.7.1 Description of the COUNT Mode. (Refer to Fig. 1.) In this mode, the unit continually counts pulses derived from the signal at the INPUT connector as long as the FUNCTION selector remains in the COUNT position. Since the Time Base Generator is not used in this mode of operation, the count indicated by the instrument is merely a tally of the total number of events which have occurred.

2.7.2 Operating Procedure. To count events, proceed as follows:

1) Couple the signal being counted to the INPUT connector (see section 2.4 for input signal requirements).

2) Set the FUNCTION selector at OFF.

3) Press the RESET button to clear the digital indicators.

4) Turn the FUNCTION selector to COUNT to start counting.

5) Turn the FUNCTION selector to OFF to stop counting.

6) Read the count displayed by the digital indicators. To resume counting without clearing the accumulated count indication, turn the FUNCTION selector back to COUNT without pressing the RESET button.

2.8 USING AN EXTERNAL CLOCK SIGNAL

For time base intervals other than those available on the instrument, an external source of clock signals can be used in place of the oscillator in the Time Base Generator. To do this, couple the external clock signal to the connector labeled EXT FREQ on the back of the instrument, and put the EXT-INT switch in the EXT position. The external signal must have an amplitude of 3 volts rms (into a 3000 ohm load); it can have a frequency as high as 200 kc.

NOTE

At frequencies much lower than 1 kc, capacitor C105 (dwg. no. 5310 D 4) may attenuate the signal below the usable level. In such a case, this capacitor should be shorted with a jumper wire and a larger capacitor connected between the signal source and the EXT FREQ connector.

With an external clock signal and the TIME-SECONDS selector in the "10-5" position, the Time Base Generator supplies clock pulses at the frequency of the external signal. At each succeeding TIME-SECONDS setting, the clock pulse frequency is divided by another power of 10. Thus, when the TIME-SECONDS selector is at "1", the clock pulse frequency is equal to that of the external signal divided by 10^5.

2.9 ACCURACY

Measurements are subject to four important sources of error.

1) Counts missed or added as the Gate opens and closes.

2) Clock signal inaccuracy.

3) Errors in the time a start or stop pulse is triggered.

4) Counts missed because they occur during the resolution time of the counting circuits.

Each of these, in turn, are discussed in the following paragraphs.

2.9.1 Error Due to Gating Time. Pulses which occur simultaneously with the opening or closing of the Gate may or may not be counted. This causes all measurements to vary plus or minus one count. The following equation defines the possible error introduced.

$$(1) \quad \text{Max. \% error} = \frac{1}{\text{Count Indication}} \times 100$$

Note that measurements set up to yield the highest count indication will be the most accurate.

The frequency of a sine wave signal can be measured directly by counting events per unit time, or indirectly by measuring the length of one period and computing frequency. Higher frequencies yield the highest count indication when measured directly, that is, using the E/UT function. Lower frequencies produce the highest indication when short time intervals are counted over one period, that is, using the PERIOD function.

Figure 2 indicates the accuracies possible at various frequencies when using the alternate methods of measurement. Note that the curves for E/UT with 1 second interval and PERIOD with 10 microsecond time unit cross at 316 cps. This indicates that for greatest accuracy, frequencies above 316 cps should be measured using the E/UT function and the 1 second counting period; frequencies below 316 cps should be measured using the PERIOD function and the 10 microsecond (10^{-5} sec.) time unit.

2.9.2 Error Due to Clock Signal Inaccuracy. All measurements requiring a time signal (i.e., all measurements except COUNT) are subject to an additional error introduced by variations in the oscillator frequency. This error can be derived from the data on oscillator stability given in section 1.2, "Technical Characteristics".

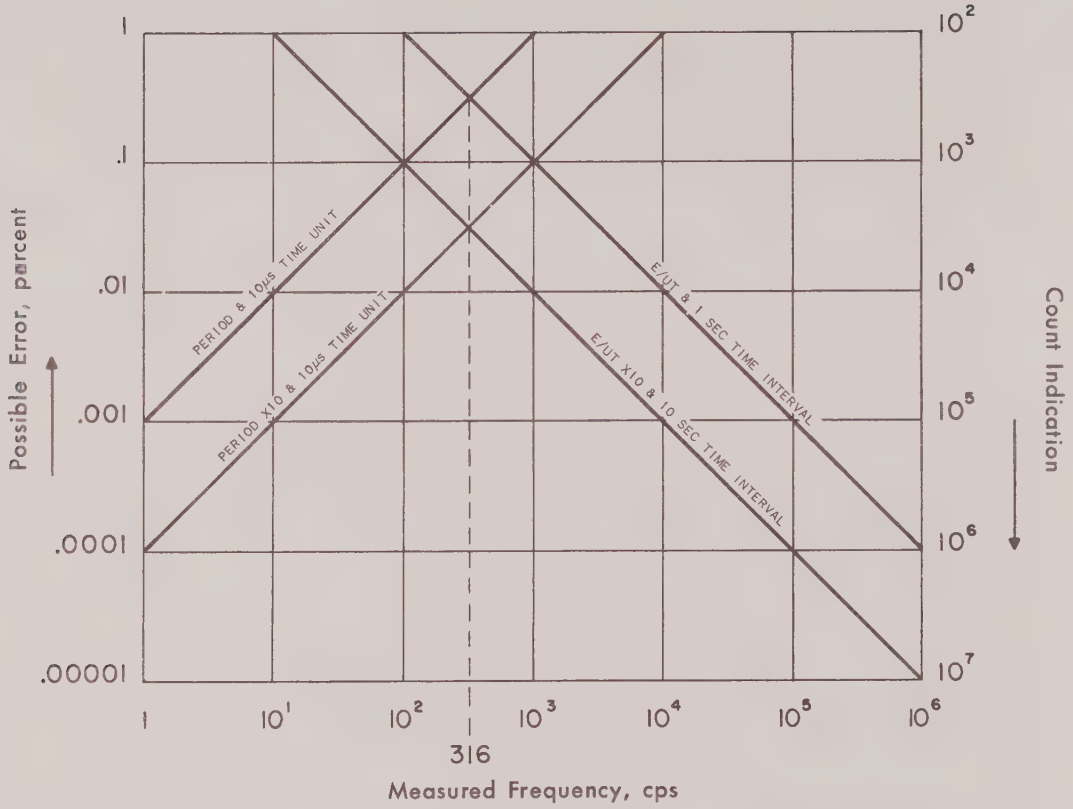


FIG. 2. The curves show percentage errors due to gating time when using alternate methods of measuring frequency. The PERIOD X 10 and E/UT X 10 functions exist only on instruments having the "B" modification.

2.9.3 Error Due to Triggering Time. Measurements using an external signal to trigger start and stop pulses (i.e., PERIOD) may be subject to a further error caused by pulses which are triggered too soon or too late. Figure 3 shows what happens during a simple period measurement.

Consider the total signal as consisting of two components: an ideal signal intended to trigger the input circuits, and a noise signal. The noise voltages added to or subtracted from the ideal signal may trigger a pulse before or after the instant at which counting should begin or end. The maximum error in the time of triggering will be proportional to the noise amplitude and inversely proportional to the slope of the ideal signal at the trigger level.

Expressed mathematically,

$$(2) \quad t(\text{secs}) = \frac{V_n \ (\text{volts})}{S \ (\text{volts/sec})}$$

where t = max. error in trigger time

V_n = peak-to-peak noise

S = slope of ideal signal at trigger level

2.9.4 Error Due to Resolution Time. Another source of error becomes important when random events are counted. One such event may occur immediately after another, before the counting circuits are fully recovered and prepared to register it. The second event will not only fail to cause a count, but its effect on the circuits may also cause failure to count a third event. Formulas for calculating the counting error due to this effect may be found in "Application of Probability Theory to Nuclear Particle Detection", L. J. Rainwater and C. S. Wu, Nucleonics, October 1947. The minimum time which must elapse between a pair of events if both are to be counted is called the resolution time of the instrument. The Model 5310 has a paired-pulse resolution time of 3 microseconds.

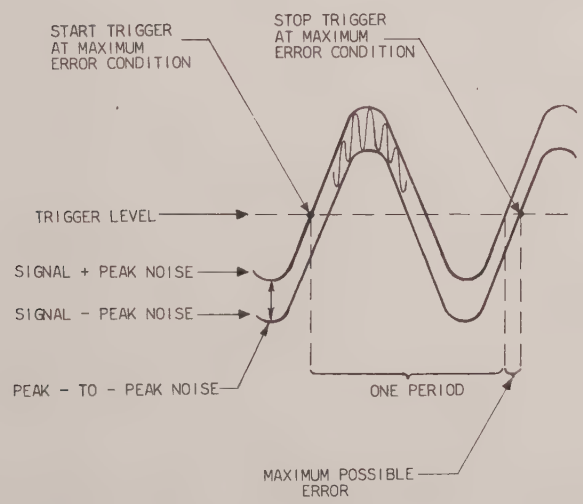

START TRIGGER AT MAXIMUM ERROR CONDITION
STOP TRIGGER AT MAXIMUM ERROR CONDITION
TRIGGER LEVEL
SIGNAL + PEAK NOISE
SIGNAL - PEAK NOISE
PEAK - TO - PEAK NOISE
ONE PERIOD
MAXIMUM POSSIBLE ERROR

FIG. 3. The effect of noise on accuracy of period measurements.

2.10 RECORDING DATA AUTOMATICALLY

To make a printed record of the count data, plug a Beckman printer (equipped for 1-2-4-8 output) into the DIGITAL RECORDER socket at the rear of the counter. The terminals of this socket are connected to the binary readout lines from each DCU in the counter as indicated in the table below. The binary coded output generated by the DCU's for each decimal digit is described in the enclosed manual for the Model 750A DCU.

Identification of Pin Numbers on DIGITAL RECORDER Socket

ORDER OF DIGIT READ	FIRST BINARY STAGE	SECOND BINARY STAGE	THIRD BINARY STAGE	FOURTH BINARY STAGE
Highest	Pin 4	Pin 3	Pin 2	Pin 1
Second	8	7	6	5
Third	12	11	10	9
Fourth	16	15	14	13
Fifth	20	19	18	17

NOTE

Pins 21 through 24 and 25 through 28 are wired to produce a "no print" code (0101).

Pin 39 carries a control signal from the counter to the recorder. This pin is negative (-12 volts) during the display period, and at approximately ground potential from the time of reset to the end of the next counting period.

Pin 40 carries an "inhibit reset" signal from the recorder to the counter. When this pin is grounded, the counter cannot reset.

Pins 30, 31, 32, 35 & 38 are grounded. Pins 22, 24, 26, 29 and 37 remain unconnected.

3. SERVICING

3.1 ROUTINE ADJUSTMENTS

3.1.1 Adjusting the Oscillator Frequency. The frequency of oscillation can be adjusted by a small amount with the XTAL ADJ control at the top of the chassis. To make this adjustment, rotate the control until the output of the oscillator (XA101, pin F) produces a zero beat with a signal from WWV or some other highly accurate frequency standard.

NOTE

Whenever the oscillator crystal is replaced, it may be necessary to change capacitor C107 so that the frequency of oscillation can be adjusted to 100 kc.

3.1.2 Adjusting the Trigger Level. The trigger level of the input Shaper circuit has initially been set at the factory, and should normally require no readjustment unless either of the Shaper transistors (Q31, Q32) has been changed. This adjustment should, however, be checked if the input sensitivity of the instrument begins to decrease. To make the adjustment, proceed as follows:

With the SENSITIVITY control in the extreme clockwise position, feed in a sine wave signal having a frequency of about 100 kc and an amplitude of 0.1 volt rms. Using an oscilloscope to observe the Shaper output at the collector of Q32, adjust the TRIGGER LEVEL control on top of the chassis so that the positive and negative portions of the signal have equal pulse widths. Now gradually reduce the input signal amplitude to the minimum at which you can still keep the pulse widths equal.

3.2 GENERAL SERVICING PROCEDURES

3.2.1 Plug-in Modules. The Model 5310 has been designed for long trouble-free operation and should rarely need servicing. Whenever trouble does occur, and is isolated to a particular plug-in module, it is recommended that the module be replaced with a spare, and the nearest factory representative contacted for repair of the defective unit.

3.2.2 Checking DCU's. If a DCU appears not to be functioning, try interchanging it with a unit in a lower decimal position. If it still does not operate, the unit has a defect and should be replaced.

3.2.3 Printed Circuit Connector Contacts. Whenever a plug-in module is removed from its socket, the connector contacts on the printed circuit board should be inspected and cleaned, if necessary. The recommended method for cleaning these contacts is buffing with a clean ink eraser.

In servicing the instrument, care should be taken to avoid shorting printed circuit connector terminals with probes or other tools.

MODIFICATIONS

A modified instrument is identified by one or more letters after the model number. For example, a Model 5310BD is a standard Model 5310 EPUT® Meter modified as described in this section under "Modification B" and "Modification D". The modifications do not necessarily appear in this section in alphabetical order.

MODIFICATION B

This modification consists of the addition of a DCU divider which extends the automatic counting period by a factor of 10 and thus provides three additional operating modes: E/UT X 10, PER X 10, and SCAN. The added divider is a Model 750A DCU which plugs into socket XA122 on the instrument chassis.

With the FUNCTION selector set at E/UT X 10 and the TIME-SECONDS selector at "1", the instrument counts events for a period of 10 seconds. Each of the other TIME-SECONDS settings is likewise multiplied by 10.

When the FUNCTION selector is set at PER X 10, the instrument counts clock pulses from its Time Base Generator over 10 periods of the input signal. The time intervals between clock pulses remain as indicated by the TIME-SECONDS selector.

With the FUNCTION switch in the SCAN position, the operator can extend the total counting period to any multiple of 10 seconds. To use the SCAN mode of operation proceed as follows:

1) Couple the signal being measured to the INPUT connector (see section 2.4 for input signal requirements).

2) Set the FUNCTION selector at E/UT X 10.

3) Set the TIME-SECONDS selector at "1".

4) Adjust the SENSITIVITY control as described in section 2.4.

5) Rotate the DISPLAY control clockwise into its "infinity" position (as indicated by a switch click).

6) Press the RESET button. The instrument will automatically begin a 10 second counting period. Before the end of this period, turn the FUNCTION selector to SCAN and begin timing a period equal to the total counting time wanted minus 10 seconds. For example, if the counting time wanted is 60 seconds, the interval to be timed is 50 seconds.

7) At the end of the interval being timed, turn the FUNCTION selector back to E/UT X 10. When the instrument stops counting, read the count displayed by the digital indicators.

MODIFICATION C

In this modification, a four-place mechanical register and register drive circuit have been added to the instrument as shown in Figure C. The input to the drive circuit comes from the output of the decimal counting unit in the most significant digit position. The mechanical register therefore tallies one count each time that DCU goes from "9" to "0". It thus extends the count capacity of the instrument by a factor of 10^4. The mechanical register is reset by pressing the small lever located just below its indicator window.

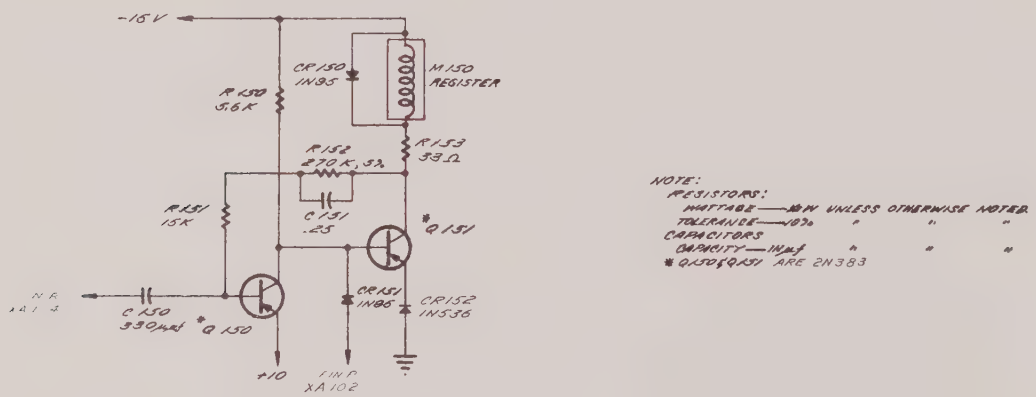


FIG. C. Mechanical register and register drive circuit added to instrument under Modification C.

MODIFICATION D

In this modification, the instrument uses a temperature-controlled crystal in the oscillator. This crystal has a stability of 5 parts in 10^7 per 24 hour period at ambient temperature of 15 to 35 degrees C. and a frequency variation of 3 parts in 10^6 over an ambient range of -20 to +65 degrees C.

The heaters in the crystal oven become energized as soon as the power cord of the instrument is plugged into an AC source. Starting at room

temperature, the oven will bring the crystal to its stable operating temperature within about half an hour. Therefore, if the instrument is to be used intermittently, the power cord should remain connected even when the instrument is not in operation. This eliminates waiting for the crystal to warm up each time the POWER switch is turned on.

MODIFICATION K

This modification provides an additional input sensitivity range designed especially to match the output characteristics of flow-meter type transducers. The modification adds several components to the instrument as shown in Figure K-1.

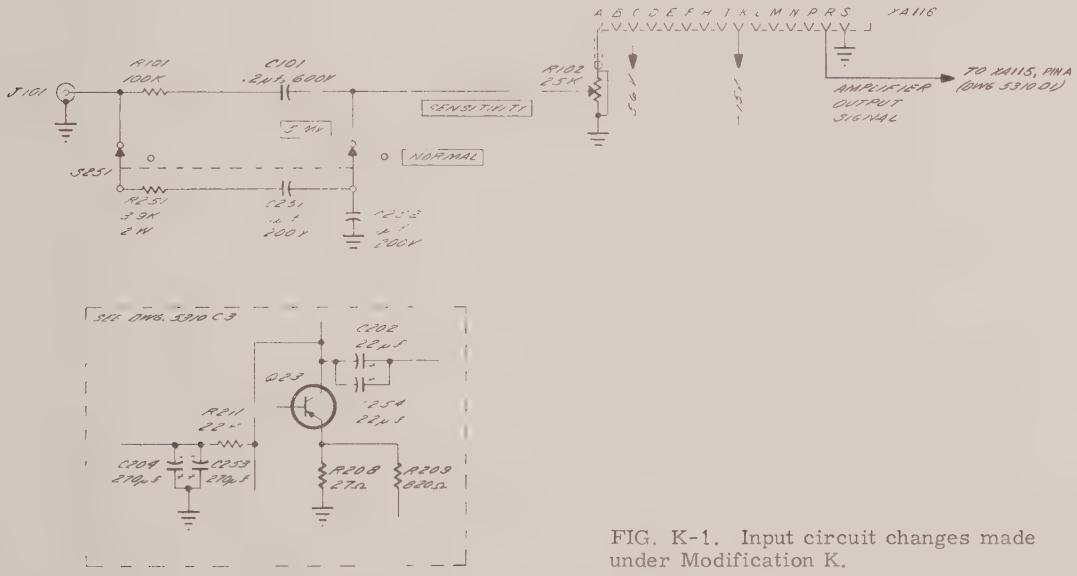


FIG. K-1. Input circuit changes made under Modification K.

The input sensitivity range is selected with a front panel switch. When this switch is in the 5MV position, the maximum sensitivity is 5 millivolts and varies typically as shown in Figure K-2. With the

switch in the NORMAL position the maximum sensitivity is that specified for the standard model.

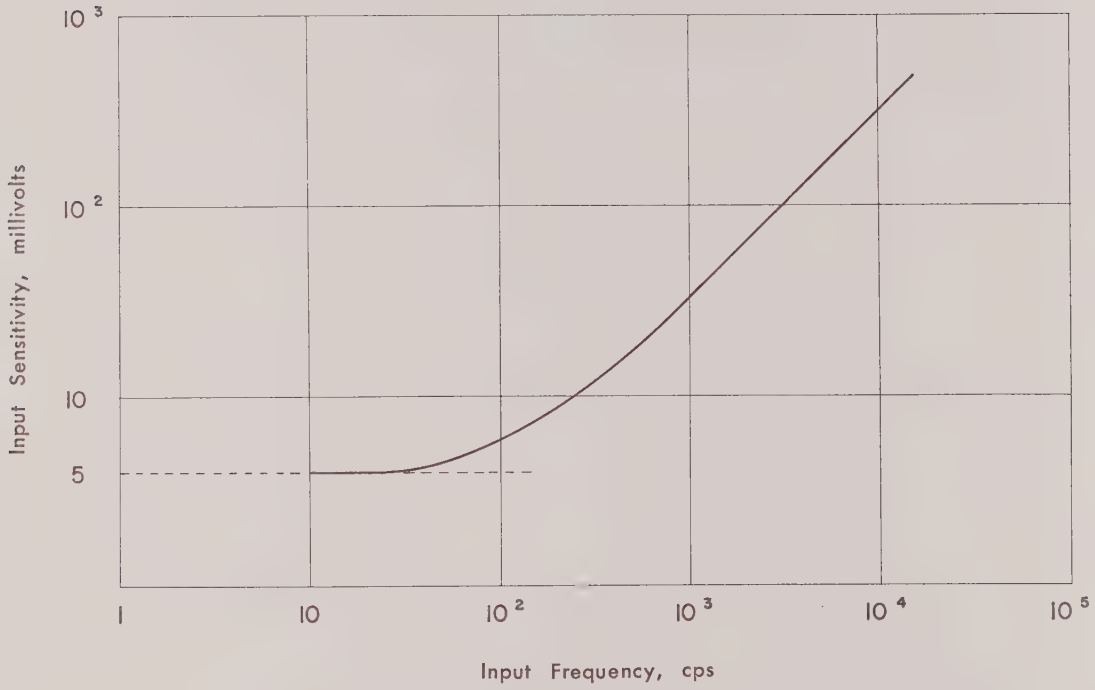
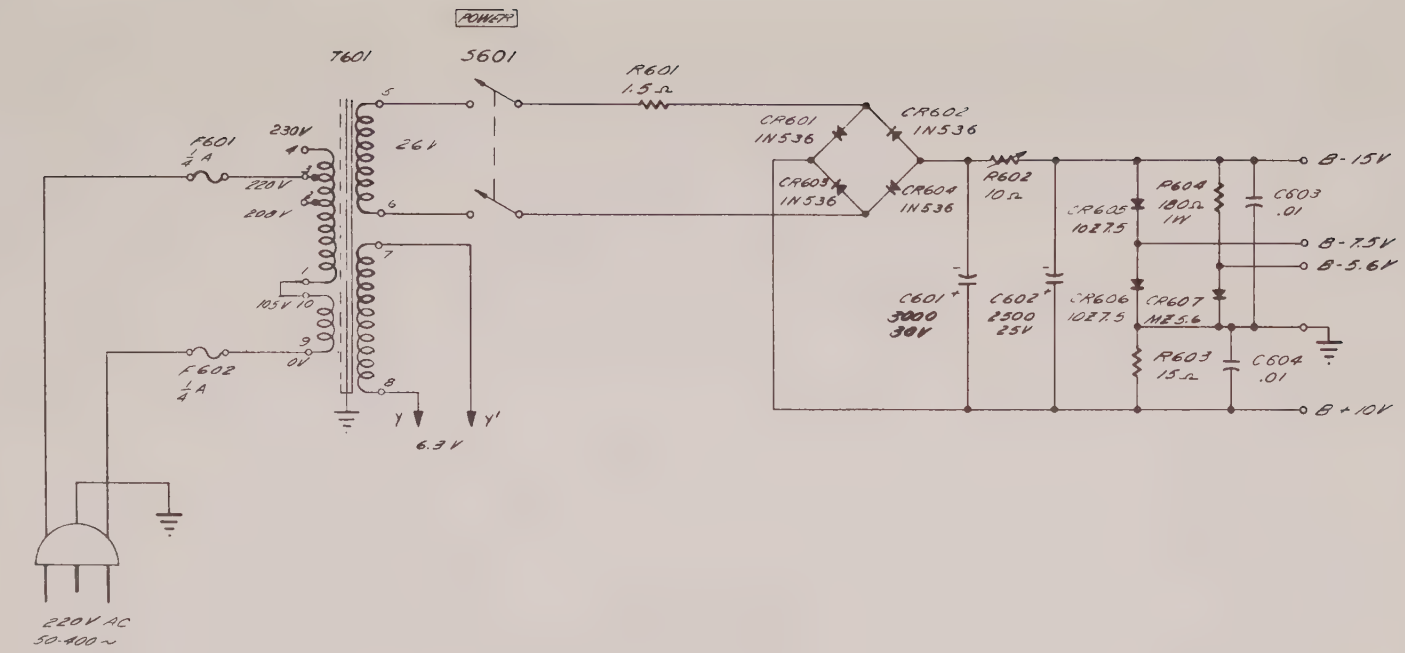


FIG. K-2. The curve shows typical variation of input sensitivity with input frequency for Modification K.

MODIFICATION H

In this modification, the instrument uses a power transformer wired so that it can be energized from a 220 volt, 50-400 cps AC source. If necessary, this transformer (T601) can be rewired for operation from a 117 volt AC line as shown in Figure H.

Note that the line fuses (F601 and F602) are rated at 1/4 a. for 220 volt operation, and 1/2 a. for 117 volt operation.



NOTES:

1. RESISTORS:
   WATTAGE IS 10W, UNLESS OTHERWISE NOTED.
   TOLERANCE IS 10%, " " "
2. CAPACITORS:
   CAPACITY IS IN μF, UNLESS OTHERWISE NOTED.

FIG. H. Schematic diagram of power supply for Modification H, showing how power transformer is wired for 220 volt and 117 volt AC operation.

MODIFICATION R

In this modification, the instrument is supplied without a cabinet but with top and bottom covers on the chassis. The unit can thus be mounted in a standard relay rack. Mounting dimensions are as shown in Figure R.

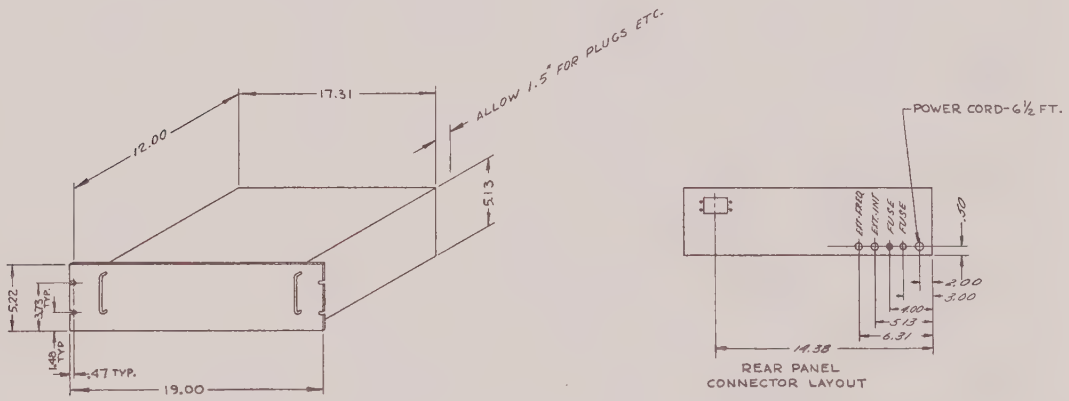


FIG. R. Rack mounting dimensions of instrument supplied with Modification R.

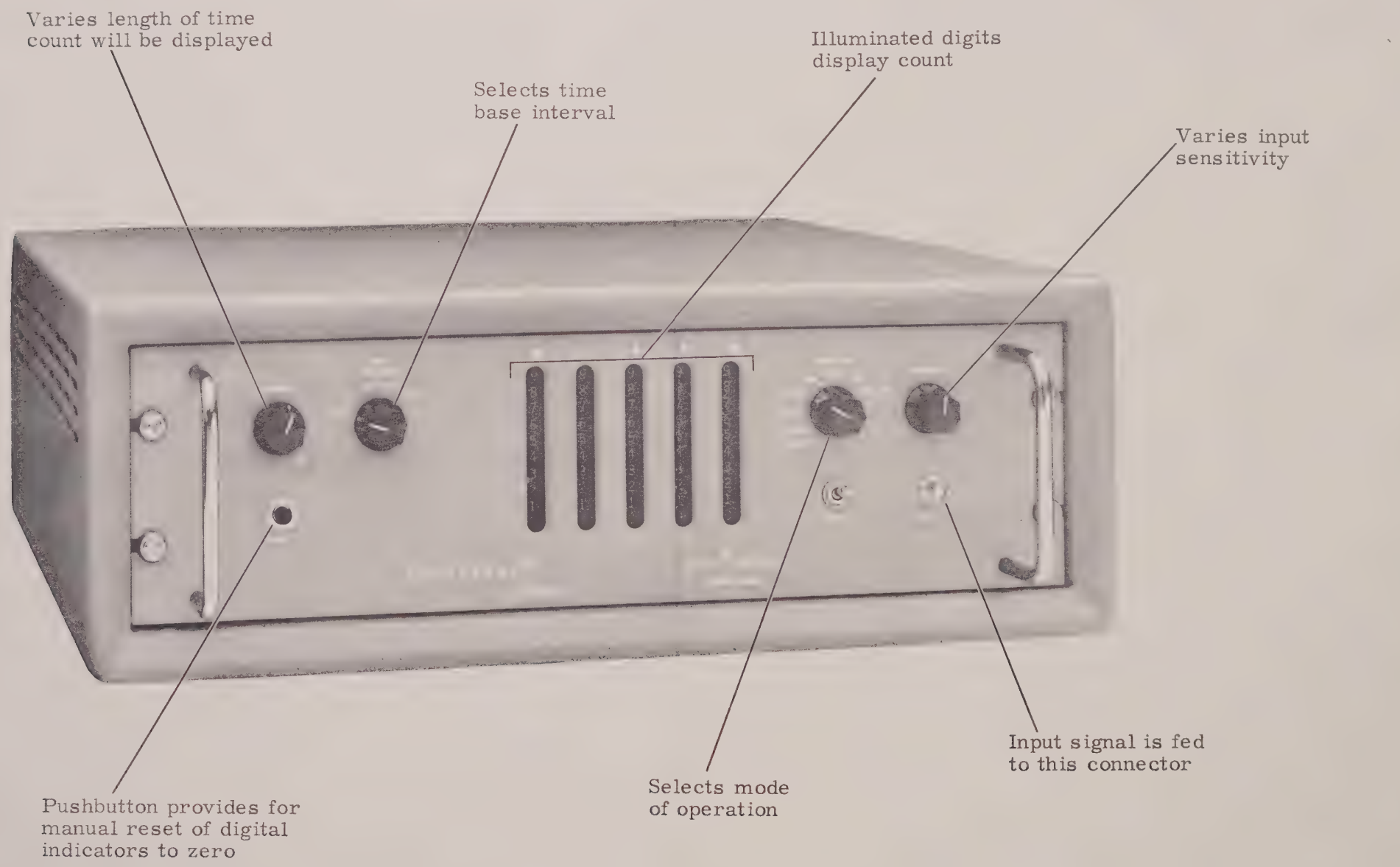
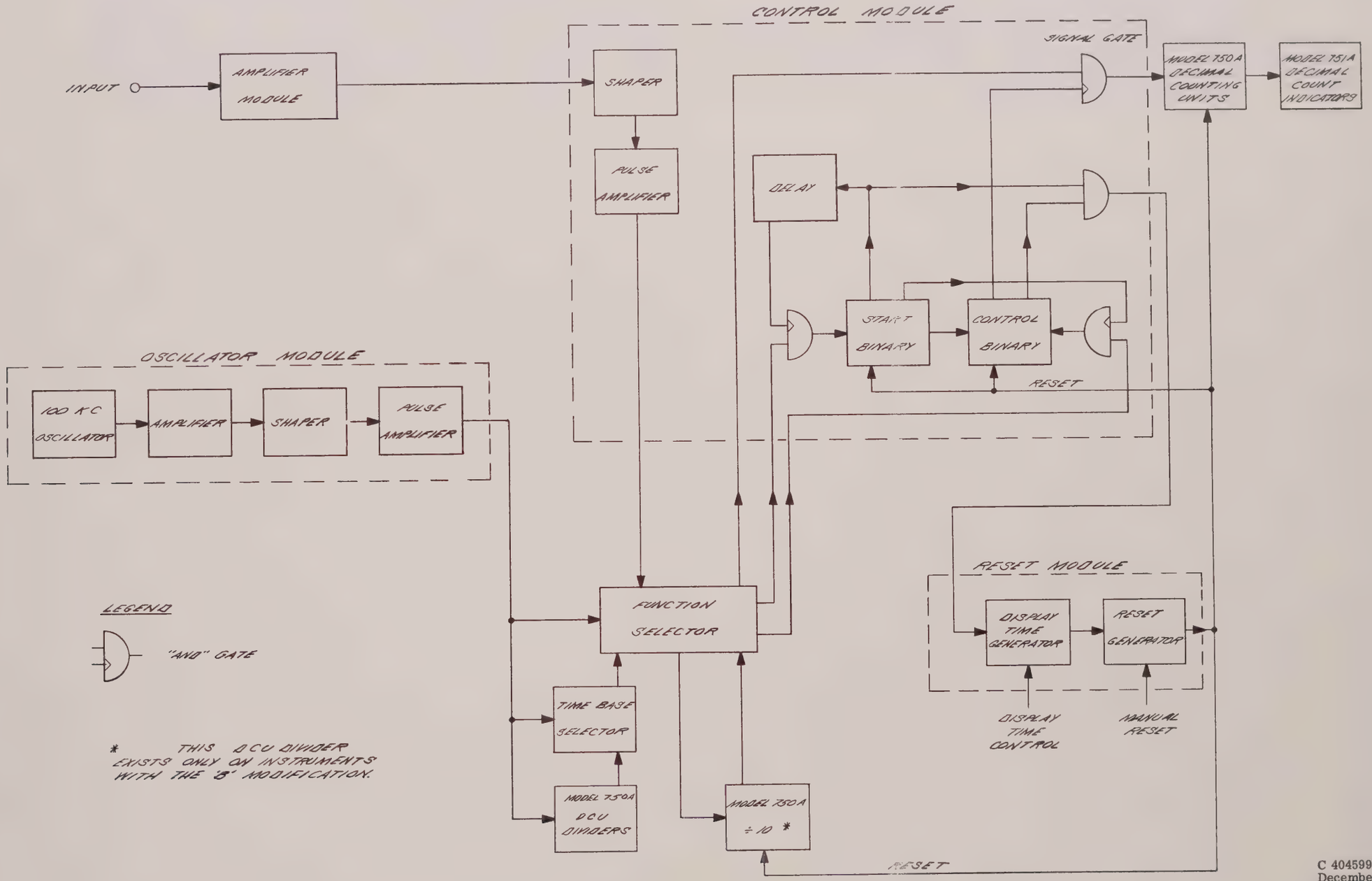

Varies length of time count will be displayed
Selects time base interval
Illuminated digits display count
Varies input sensitivity
Pushbutton provides for manual reset of digital indicators to zero
Selects mode of operation
Input signal is fed to this connector

FIG. 4. The operating controls and indicators on the Model 5310.

MODEL 5310 EPUT® METER
BLOCK DIAGRAM



C 404599-Rev. A
December 1961

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PARTS LIST, MASTER SCHEMATIC DIAGRAM

NOTE

The following parts list includes all electrical components except fixed composition resistors whose value, rating, and tolerance are given on the schematic diagram.

Detail No.	Berkeley Stock No.	Description	Manufacturer & No.
C101	804941	Capacitor, paper, 0.2μf, 600V, 10%	Hopkins
C102	804761	Capacitor, mica, 150μμf, 500V, 5%	Sangamo
C103 & C104		Same as C102	
C301	804750	Capacitor, mica, 68μμf, 500V, 5%	Sangamo
C302	804769	Capacitor, mica, 330μμf, 500V, 5%	Sangamo
C303	802880	Capacitor, electrolytic, 1μf, 70V, -20% +60%	Barco, Inc.
C304	804765	Capacitor, mica, 220μμf, 500V, 5%	Sangamo
C305		Same as C304	
C306		Same as C102	
C307 & C308		Same as C304	
C309	807485	Capacitor, mica, 100μμf, 500V, 5%	Sangamo
C310	804777	Capacitor, mica, 500μμf, 500V, 5%	Sangamo
C401	802977	Capacitor, electrolytic, 8μf, 30V, -10% +250%	Sprague
C402	808618	Capacitor, plastic, .0047μf, 400V, 20%	Good-All
C403	804718	Capacitor, ceramic, .01μf, 600V, guaranteed minimum value	Erie
C404		Same as C302	
C406		Same as C310	
C407	804708	Capacitor, ceramic, .0015μf, 600V, 10%	Erie
CR101	800272	Diode, 1N95	Hughes
CR301	"	Same as CR101	
CR302	800274	Diode, 1N198	Hughes
CR303		Same as CR302	
CR304		Same as CR101	
CR305 & CR306		Same as CR302	
CR307		Same as CR101	
CR308		Same as CR301	
CR309		Same as CR101	
CR401	800301	Diode, 1N536	Hughes
CR402	404593	Diode	Beckman/Berkeley
CR403 thru CR405		Same as CR101	
CR406		Same as CR402	
CR407		Same as CR302	
J101	806738	Connector, coaxial	Automatic Metals
Q31	800398	Transistor, 2N404	RCA
Q32 thru Q39		Same as Q31	
Q41	800375	Transistor, 2N214	Sylvania
Q42	099433	Transistor, 2N383	Beckman/Berkeley
Q43 & Q44		Same as Q42	
R102	806321	Potentiometer, 25K, 2W, 20%,	Allen Bradley
R103	806318	Potentiometer, 5K, 2W, 20%	Allen Bradley
R104	811307	Potentiometer, 1M, 1/2W, 20%, w/switch	Centralab
S101	401956	Switch, rotary	Beckman/Berkeley
S102	401957	Switch, rotary	Beckman/Berkeley
S103	043278	Switch, pushbutton	Switchcraft
S104		Part of R104	
XA102	812752	Socket	Beckman/Berkeley
XA115 & XA116		Same as XA102	
XA122		Same as XA102	

Model 5310
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D 404597

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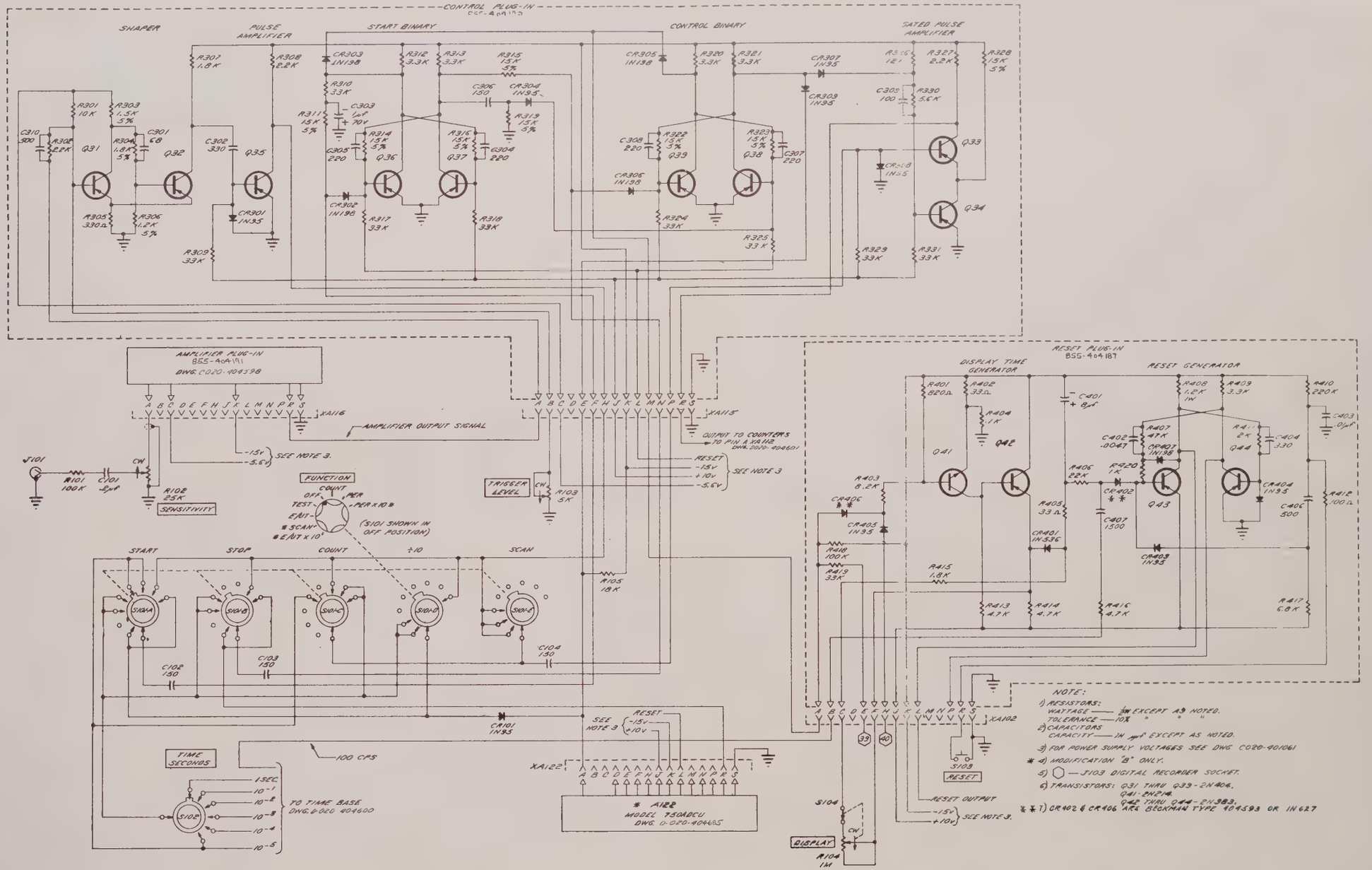
MASTER SCHEMATIC DIAGRAM



D 404597-Rev. C
December 1961

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PARTS LIST, INPUT AMPLIFIER

NOTE

The following parts list includes all electrical components except fixed composition resistors whose value, rating, and tolerance are given on the schematic diagram.

Detail No.	Berkeley Stock No.	Description	Manufacturer & No.
C202	802980	Capacitor, electrolytic, 22μf, 25V, 20%	Sprague
C203	804740	Capacitor, mica, 22μμf, 500V, 5%	Sangamo
C204	802984	Capacitor, electrolytic, 270μf, 6V, 20%	Sprague
C205	804745	Capacitor, mica, 39μμf, 500V, 5%	Sangamo
L201	807871	Inductor, 5 millihenry	National Coil
Q21	407814	Transistor, 2N1027 (Selected)	Beckman/Berkeley
Q22	800398	Transistor, 2N404	RCA
Q23		Same as Q22	
RT201	802561	Thermistor	Victory Engineering

Model 5310
December 1961
C404598

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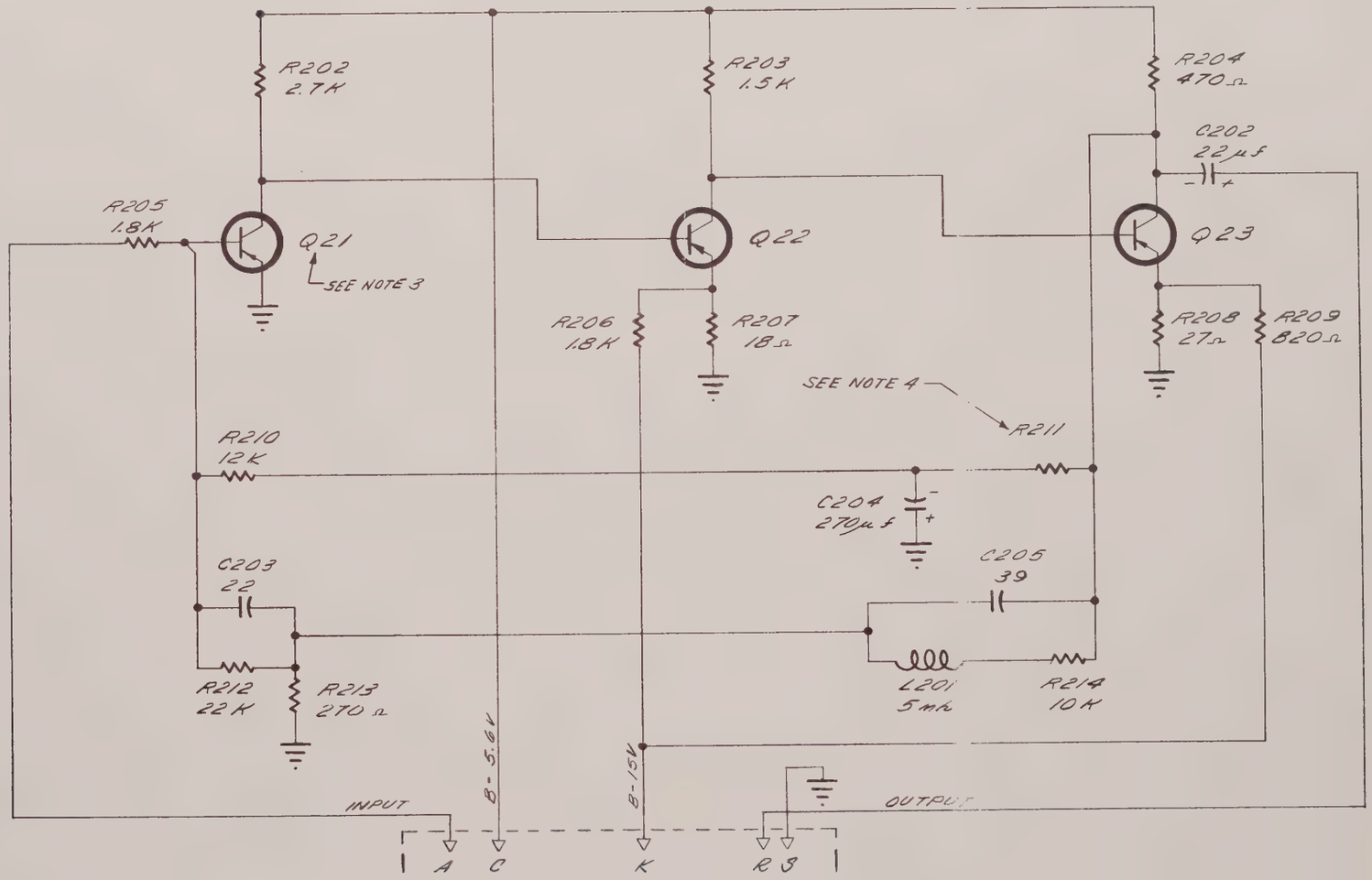
INPUT AMPLIFIER
SCHEMATIC DIAGRAM

NOTES:

1. RESISTORS:
   WATTAGE IS 1/2 W, UNLESS OTHERWISE NOTED.
   TOLERANCE IS 10%, " " "
2. CAPACITORS:
   CAPACITY IS IN μμf, UNLESS OTHERWISE NOTED.
3. TRANSISTORS: Q22 & Q23 - TYPE 2N404, Q21 - BERKELEY PART 755-407814 (2N1027 SELECTED hfe 245)
4. VALUE OF R211 (SELECTED AT FACTORY) IS BETWEEN 10K AND 47K.



C 404598-Rev. B
December 1961

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PARTS LIST, TIME BASE GENERATOR

NOTE

The following parts list includes all electrical components except fixed composition resistors whose value, rating, and tolerance are given on the schematic diagram.

Detail No.	Berkeley Stock No.	Description	Manufacturer & No.
C105	804718	Capacitor, ceramic, .01μf, 600V, guaranteed minimum value	Erie
C106	805009	Capacitor, variable ceramic, 12-60μμf, 600V	Centralab
C107	Selected	Capacitor, mica, (approx. 68μμf)	Beckman/Berkeley
C108	804871	Capacitor, paper, 0.25μf, 200V, 20%	Hopkins
C501	804775	Capacitor, mica, 470μμf, 300V, 5%	Sangamo
C502	802883	Capacitor, electrolytic, 5μf, 8V, -20% +60%	Barco
C503	804767	Capacitor, mica, 270μμf, 500V, 5%	Sangamo
C504	804790	Capacitor, mica, 1000μμf, 500V, 5%	Sangamo
C505	804797	Capacitor, mica, 2500μμf, 300V, 5%	Sangamo
C506		Same as C505	
C507	804750	Capacitor, mica, 68μμf, 500V, 5%	Sangamo
C508	804769	Capacitor, mica, 330μμf, 500V, 5%	Sangamo

Detail No.	Berkeley Stock No.	Description	Manufacturer & No.
CR501	800272	Diode, 1N95	Hughes
I101		Part of XI101	
J102	806738	Connector, coaxial	Automatic Metals
L501	807866	Inductor, 1000μh	National Coil
Q51	405152	Transistor, 2N404	Beckman/Berkeley
Q52		Same as Q51	
Q53	800398	Transistor, 2N404	RCA
Q54 & Q55		Same as Q53	
S105	004254	Switch, toggle, SPST	Cutler-Hammer
XA117 thru XA121	812752	Socket	Beckman/Berkeley
XI101	801187	Lamp Assembly w/328 lamp	Dialight
XY101	802333	Socket	Elco
Y101	401955	Crystal	Beckman/Berkeley
Y101 (D Mod. only)	13-7787	Crystal	Beckman/Berkeley

Model 5310
December 1961
D 404600

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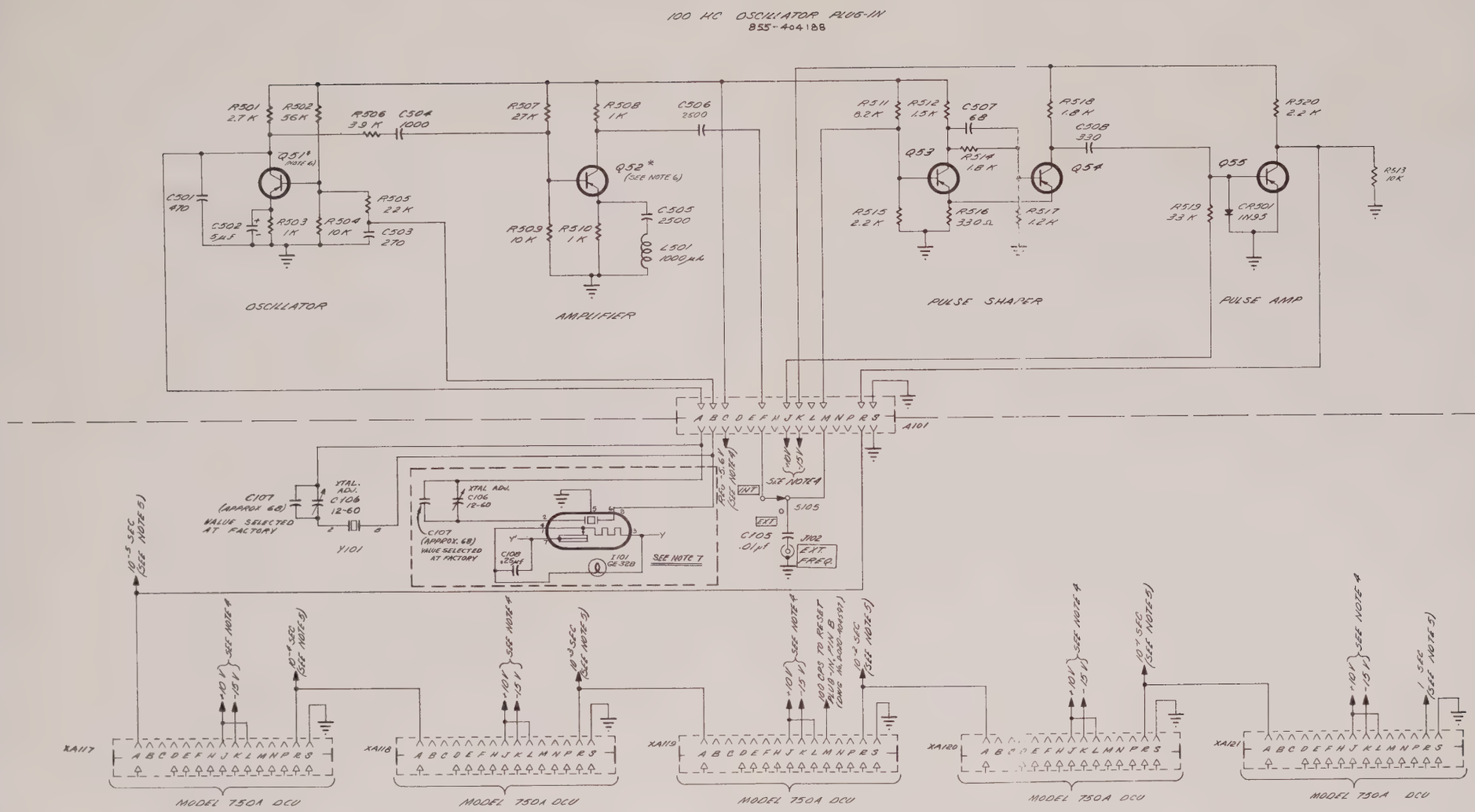
TIME BASE GENERATOR SCHEMATIC DIAGRAM



NOTES:

1. RESISTORS:
   WATTAGE IS 1/2 W, UNLESS OTHERWISE NOTED.
   TOLERANCE IS 10%, " " "
2. CAPACITORS:
   CAPACITY IS IN μμf, UNLESS OTHERWISE NOTED.
3. TRANSISTORS ARE 2N404.
4. FOR POWER SUPPLY VOLTAGES, SEE DWG Nº C020-401061
5. TIME BASE OUTPUT SIGNAL TO SWITCH Nº S103, DWG Nº D020-404397
6. SELECTED 2N404, CURRENT GAIN, h_{fe}, > 35 AT V_c=6V, I_c=2ma.
7. HEATED CRYSTAL ON 'D' MOD ONLY

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December 1961

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PARTS LIST, COUNTING CIRCUIT

NOTE

The following parts list includes all electrical components except fixed composition resistors whose value, rating, and tolerance are given on the schematic diagram.

Detail No.	Berkeley Stock No.	Description	Manufacturer & No.
XA103	815353	Socket	Ucinite
XA104 thru XA112		Same as XA103	

Model 5310
December 1961
D 404601

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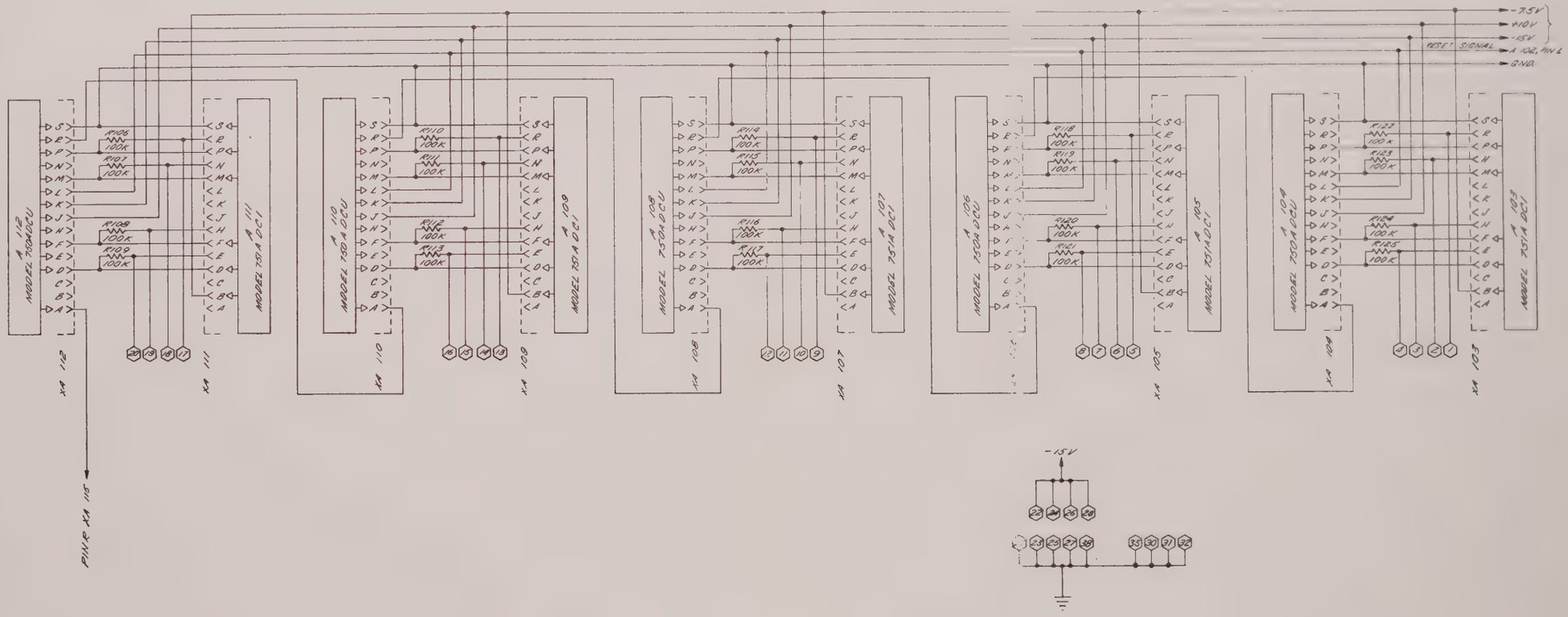
COUNTING CIRCUIT SCHEMATIC DIAGRAM



NOTE
RESISTORS:
WATTAGE — 1/2 W UNLESS OTHERWISE NOTED.
TOLERANCE — 10% " " "

⬡ NUMBERS INDICATE PINS OF DIGITAL RECORDER SOCKET, J103.

D 404601-Rev. A
December 1961

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PARTS LIST, POWER SUPPLY

NOTE

The following parts list includes all electrical components except fixed composition resistors whose value, rating, and tolerance are given on the schematic diagram.

Detail No.	Berkeley Stock No.	Description	Manufacturer & No.
C601	401953	Capacitor, electrolytic, 3000μf, 30V, -10% +250%	Beckman/Berkeley
C602	802934	Capacitor, electrolytic, 2500μf, 25V, -10% +250%	Mallory
C603	804718	Capacitor, ceramic, .01μf, 600V, guaranteed minimum value	Erie
C604		Same as C603	
CR601	800301	Diode, 1N536	Hughes
CR602		Same as CR601	
CR603 & CR604		Same as CR601	
CR605	800356	Diode, Zener, 10Z7.5V	International Rectifier
CR606		Same as CR605	
CR607	800341	Diode, Zener, MZ5.6V	International Rectifier
F601	801552	Fuse, 1/2 Amp.	Littelfuse
F602		Same as F601	
R601	800929	Resistor, wirewound, 1.5Ω 10W, 10%	Tru-Ohm
R602	811317	Resistor, wirewound, 10Ω, 10W, 10%	Ohmite
R603	800931	Resistor, wirewound, 15Ω, 10W, 10%	Tru-Ohm
S601	006595	Switch, toggle, DPST	Cutler-Hammer
T601	401958	Transformer, power	Beckman/Berkeley

Model 5310
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C 401061

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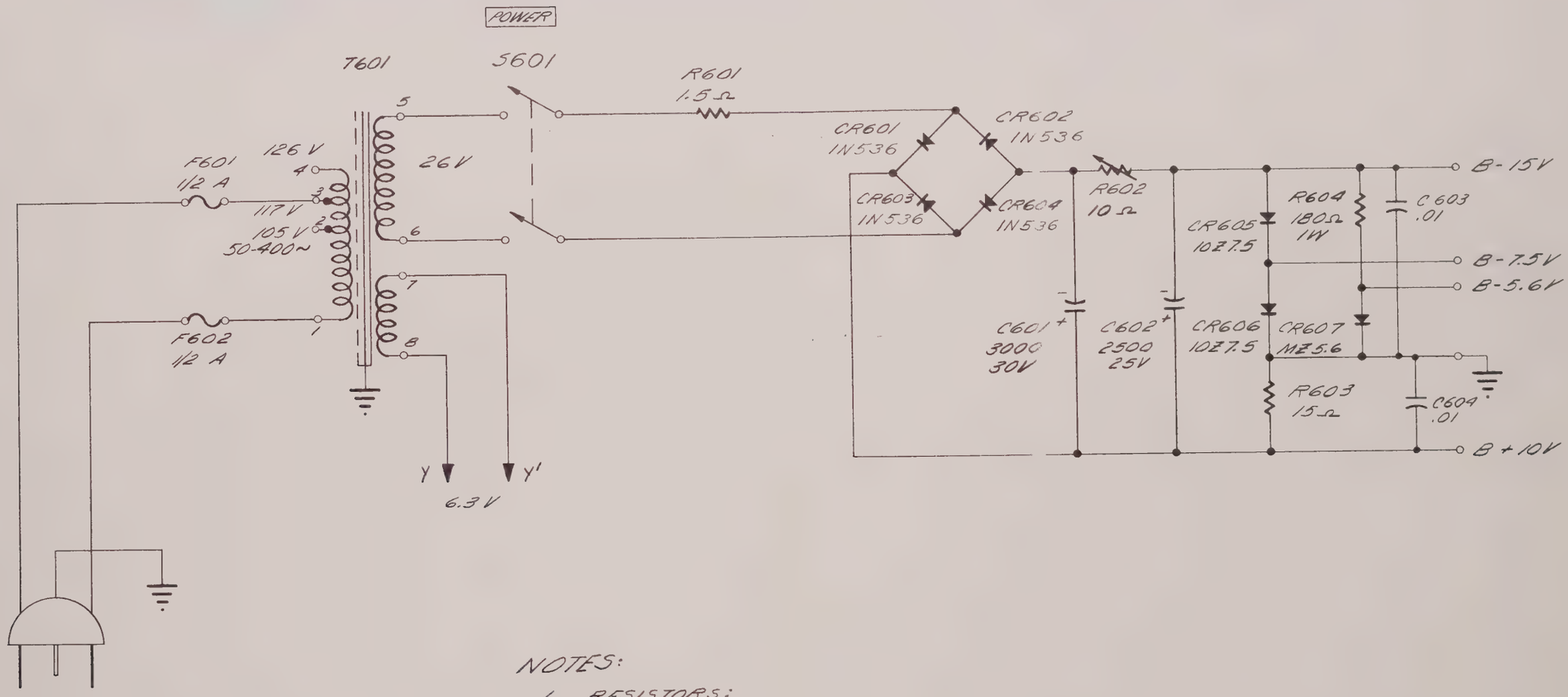
POWER SUPPLY SCHEMATIC DIAGRAM



NOTES:

1. RESISTORS:
   WATTAGE IS 10W, UNLESS OTHERWISE NOTED.
   TOLERANCE IS 10%, " " "
2. CAPACITORS:
   CAPACITY IS IN μF, UNLESS OTHERWISE NOTED.

C401061-Rev. E
December 1961

Beckman

INSTRUCTION MANUAL

MODEL 750A
DECIMAL COUNTING UNIT

Beckman/Berkeley Division
Richmond, California

April 1961

WARRANTY

Instruments sold by Berkeley Division, Beckman Instruments, Inc., (hereafter called "the Company") are warranted only as stated below.

Subject to the exceptions and upon the conditions specified below, the Company agrees to correct, either by repair, or, at its election, by replacement, any defect of material or workmanship which develops within one year after delivery of the instrument to the original purchaser by the Company or by an authorized representative, provided that investigation and factory inspection by the Company discloses that such defect developed under normal and proper use.

The exceptions and conditions mentioned above are the following:

(a) Some components and accessories by their nature are not intended to, and will not, function one year. If any such component or accessory manufactured by the Company and part of the item sold fails to give reasonable service for a reasonable period of time, the Company will, at its election, replace or repair such component or accessory. What constitutes reasonable service and what constitutes a reasonable period of time shall be determined solely by the Company after the Company is in posession of all the facts concerning operating conditions and other pertinent factors and after such component or accessory has been returned to the Company, transportation prepaid.

(b) All instruments claimed defective must be returned to the Company, transportation charges prepaid, and will be returned to the customer with the transportation charges collect, unless the item is found to be defective in which case the Company will pay all transportation charges.

(c) The Company makes no warranty concerning components or accessories not manufactured by it, such as tubes, fuses, batteries, etc. However, in the event of the failure of any component or accessory not manufactured by the Company, the Company will give reasonable assistance to the purchaser in obtaining from the respective manufacturer whatever adjustment is reasonable in the light of the manufacturer's own warranty.

(d) Except as stated above, the Company makes no warranty, express or implied (either in fact or by operation of law), statutory or otherwise; and, except to the extent stated above, the Company shall have no liability under any warranty, express or implied (either in fact or by operation of law), statutory or otherwise.

(e) The Company expressly disclaims any liability to its customers, dealers, and to users of its products, and to any other person or persons for consequential damages of any kind and from any cause whatsoever arising out of or in any way connected with the manufacture, sale, repair, replacement of, or arising out of or in any way connected with the use of any of its products.

(f) Representations and warranties made by any person, including representatives of the Company, which are inconsistent or in conflict with the terms of this warranty (including but not limited to the limitation of the liability of the Company as set forth above) shall not be binding upon the Company unless reduced to writing and approved by an officer of the Company.

(g) This warranty shall be governed by the laws of the State of California.

Claims for damage in shipment should be filed promptly with the transportation company.

All correspondence concerning the instrument should specify the model and serial number. This information appears on the company name plate. Any inquiry concerning details of operation, possible modifications, etc., should be addressed to the Sales Department, Berkeley division of Beckman Instruments, Inc., Richmond 4, California.

REPAIR SERVICE

Experienced service personnel and special test equipment are available at the factory to perform any necessary repairs. Every effort will be made to expedite the repair of instruments returned for servicing. Repair work will be performed only upon receipt of a written purchase order or authorization. Instruments to be repaired should be addressed to SERVICE AND REPAIR DEPARTMENT with transportation charges prepaid. Repaired instruments will be returned to the purchaser with transportation charges collect.

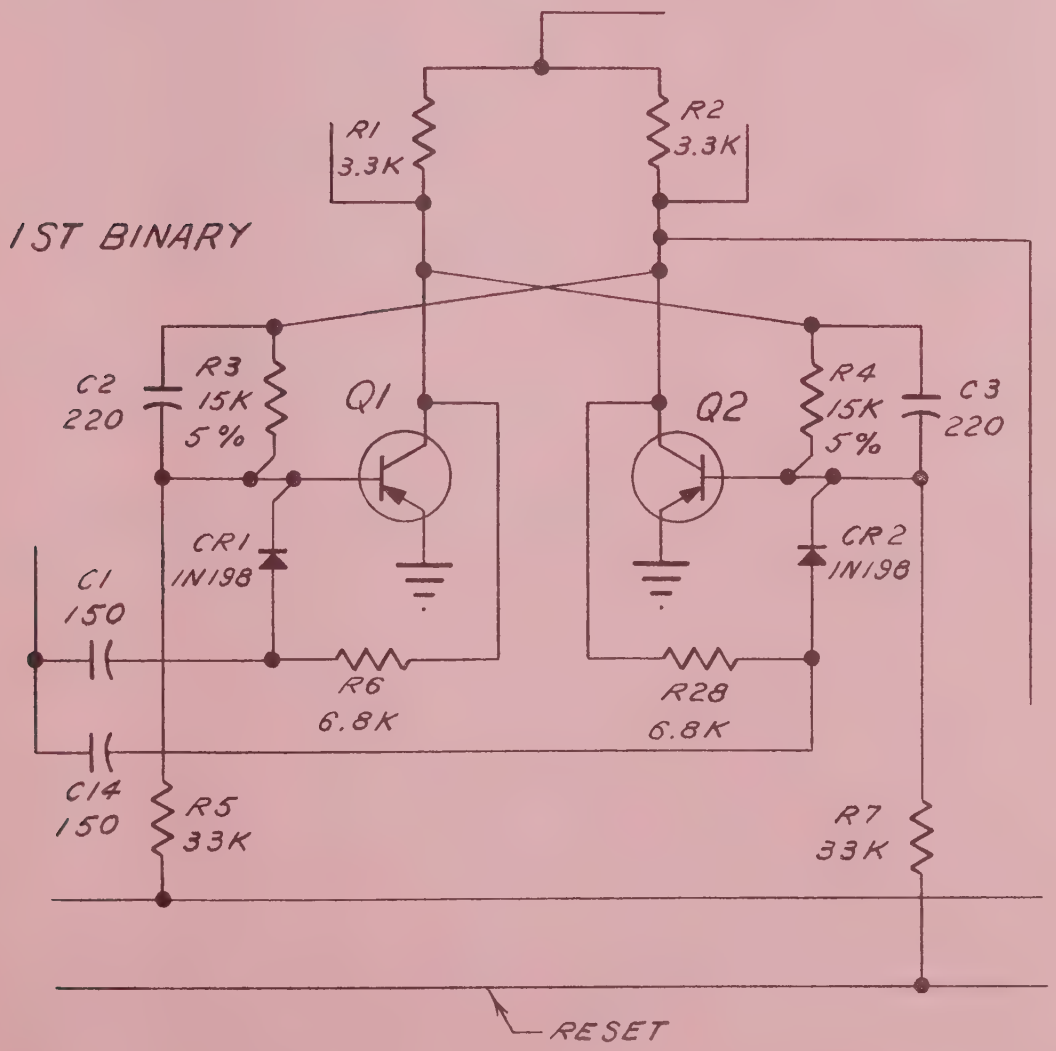
Berkeley reserves the right to make changes in design at any time without incurring any obligation to modify equipment previously purchased to conform to subsequent design changes.

BERKELEY DIVISION
BECKMAN INSTRUMENTS, INC.

INSTRUCTION MANUAL REVISION

Model 750A, lots 1 through 8 (Does not apply to lots 1A through 8A).

Please note that the First Binary circuit is somewhat different from that shown in the schematic diagram. The revised circuit is as follows:



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Model 750A DCU, Schematic Diagram

1. INTRODUCTION

1.1 GENERAL DESCRIPTION

The Model 750A DCU is a plug-in electronic counting unit made up entirely of solid state components mounted on a printed circuit board. The unit provides a count of input pulses from zero to nine, each count being represented by output signals in binary (1-2-4-8) coded form. With a Model 751A Decimal Count Indicator, this binary-coded output can be converted into a decimal digit display of the registered count.

At every tenth input pulse, the counter is reset to zero and simultaneously generates an output signal which can be used to drive another Model 750A DCU. Thus, any number of these units can be cascaded (the output of one connected to the input of the next) to form a counter whose total count capacity depends only on the number of DCU's.

Since each DCU generates one output pulse for every ten input pulses, these units can also be used as decade frequency dividers.

1.2 TECHNICAL CHARACTERISTICS

Count Indication

Binary-coded (1-2-4-8) electrical signals

Input Requirements

Voltage pulse, +10 to +25 volts amplitude*, 1μs minimum duration (0.5μs rise time).

Maximum Counting Rate

200,000 counts per second

Resolution of Paired Pulses

3 microseconds

---

*The values given correspond to supply voltage levels listed under "Power Requirements". For values when other supply voltages are used, see Section 2.6.

Output Characteristics

Positive signal when count goes from "9" to "0", suitable for driving another Model 750A DCU.

Reset Requirement

Voltage pulse, -16 v amplitude*, 20μs minimum duration.

Power Requirements

22 ma at -15 v. (±5%)
2 ma at +10 v. (±5%)

(NOTE: The unit can operate at other voltage levels as well; see Section 2.6).

Construction

Printed card plug-in unit (with 15-pin printed circuit connector).

Dimensions

1/2 inch wide, 4-1/16 inches high, 4-1/2 inches deep

Weight

2-1/2 oz.

*The values given correspond to supply voltage levels listed under "Power Requirements". For values when other supply voltages are used, see Section 2.6.

2. OPERATION

2.1 MOUNTING THE UNIT

The DCU can be mounted by plugging into a 15-pin printed-card connector. When plugged into a connector having lettered terminals, the DCU should be inserted so that the INPUT line on the card corresponds to terminal A on the connector.

2.2 SUPPLYING POWER

Ordinarily, the unit operates with supply voltages of -15 volts and +10 volts, but other voltage levels can be substituted as indicated in Section 2.6. The negative voltage supply should be connected to pin K of the DCU connector, while the positive supply should be connected to pin J.

2.3 SUPPLYING INPUT SIGNALS

Connect the source of input signals to pin A of the DCU connector. The unit will register a count each time a pulse +10 to +25 volts in amplitude (with a minimum width of 1μs and a 0.5μs rise time) is applied to the input terminal.

2.4 USING OUTPUT SIGNALS

The unit provides readout signals in the form of high and low potentials at eight terminals of the DCU connector. These signals indicate the state of each binary and hence the registered count in 1-2-4-8 binary code.

At terminals E, H, N and R, the high potential indicates that the corresponding binary is in the "one" state, while the low potential represents the "zero" state. At terminals D, F, M and P, on the other hand, the potentials for each state are reversed. That is, the "one" state is represented by the low level and the "zero" state by the high level. Table I indicates the state of the binaries for each registered count from 0 to 9.

Table I. State of the Binaries

REGISTERED COUNT	FIRST BINARY	SECOND BINARY	THIRD BINARY	FOURTH BINARY
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1

With a B- supply of -15 volts, the high potential has a value of about -12 volts with respect to ground (pin S) while the low potential is at about zero volts. Each readout line will supply a maximum steady state current of 2 ma into a load connected to B-.

The readout signals at terminals D, F, M and P can be used to drive a Model 751A DCI for a visual indication of the registered count. In addition, the output signal produced at terminal R each time the count goes from 9 to 0 can be used to drive another Model 750A DCU or other circuitry.

2.5 RESETTING COUNTER TO ZERO

While the unit is counting, the reset line (terminal L) must be clamped at the level of the B+ supply (+10 volts). The unit can be reset to zero by a negative voltage pulse applied to terminal L of the DCU connector. This pulse must have an amplitude of -16 volts with respect to the +10 v. level, and a duration of at least 20 microseconds. It can be generated either electronically by a transistor circuit or mechanically through relay contacts.

NOTE

Whenever DCU's are connected in cascade, the reset signal must have a minimum duration equal to 20 microseconds times the number of units in the chain in order to reset all of them.

2.6 SPECIAL OPERATING CONDITIONS

Although the operating characteristics described in previous sections are for power supply levels of -15 and +10 volts, the unit will function at other voltages as well. In fact, proper combinations of B- and B+ voltages down to -8 and +4 volts respectively can successfully be used.

Those characteristics which are affected by the supply voltage levels will naturally vary with the value of the voltages used. Thus, for example, with a B- and B+ voltage of -8 and +4 volts, the amplitudes of the input, output, and reset signals will be approximately as follows (signal widths remain unchanged):

1)	Input signal:	+5 to +15 volts
2)	Output signal:	Potentials of 0 and -6 volts with respect to ground.
3)	Reset signal:	-8 volts with respect to B+.

3. CIRCUIT DESCRIPTION

3.1 THE BINARIES

The decimal counting unit consists of four binaries, each made up of a pair of p-n-p transistors, connected in a scale-of-ten circuit. The transistor binaries are similar to vacuum tube binaries in that they have two stable states, and are alternately triggered from one state to the other by successive input pulses.

The major difference between the two types of binary is due to the operating characteristics of the transistors. In a transistor, the input impedance is relatively low (in the order of a thousand ohms) when the base potential is negative. This low impedance allows a base current to flow and the transistor is able to conduct. On the other hand, a positive base potential results in a relatively high input impedance (several hundred thousand ohms). Consequently no base current flows and the transistor is, in effect, cut off.

Assume, for example, that the first binary on the schematic diagram is initially in the "zero" state. In this state, Q2 is conduting while Q1 is cut off. A positive input voltage pulse applied through diode CR2 to the base of Q2 drives this transistor to cutoff. As a result, the base current that normally flows is diverted and Q2 therefore stops conducting.

The same input pulse which is applied to CR2 cannot change the state of Q1 since this transistor is already cut off.

As the load current in Q2 decreases, the potential on the collector approaches the level of the B- supply. This change in voltage level is coupled through resistor R3 and capacitor C2 to the base of transistor Q1 and drives Q1 into the active region. As a result, Q1 begins to conduct, and the amplified current flowing through resistor R1 causes the potential on the collector to fall almost to zero. Under these conditions, the divider network consisting of R4 and R7 applies a large enough positive potential to the base of Q2 to keep it cut off.

The binary, now in the "one" state, remains in this stable state until the next positive input pulse arrives. When this happens, Q1 is cut off, Q2 conducts, and the binary thus resumes its original state.

The collector of each transistor in the four binaries is tied to a corresponding terminal of the DCU connector. Thus, the change in voltage level at each collector, as the binary changes state, is available as an output signal. In addition, one output of each binary is also used as the input to the following binary. Consequently, each binary in the DCU reverses state for every two reversals of the preceding binary.

3.2 THE SCALE-OF-TEN CIRCUIT

The scale-of-ten circuit used in the Model 750A DCU is actually a four-place binary counter wired in such a way that it resets to zero on every tenth input pulse. Thus, for the first nine pulses, the binaries operate as in a conventional, 1-2-4-8 counter. At the count of eight, however, the negative potential on the collector of Q8 is fed back through resistor R13 to the second binary. This places a bias on diodes CR8 and CR4 so that the next positive pulse from Q2 will not trigger the second binary.

The tenth input pulse, then, flips the first binary to its "zero" state, but the corresponding positive transient at the collector of Q2 cannot trigger the second binary to the "one" state. However, this positive transient, coupled through C13, does trigger the fourth binary to its "zero" state.

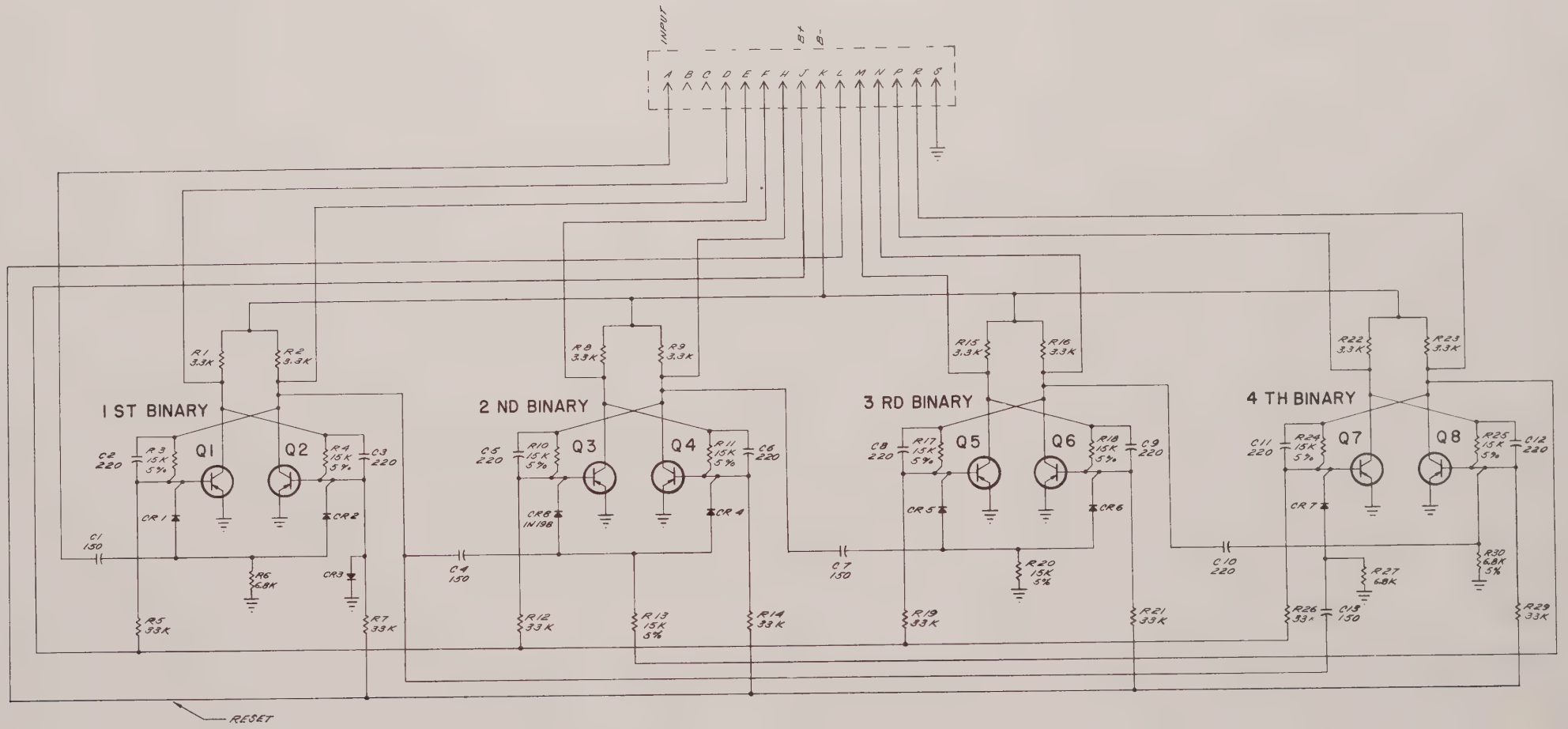
At the tenth input pulse, therefore, all four binaries are in the "zero" state, the bias on diodes CR3 and CR4 has been removed, and the circuit is ready for the next counting cycle.

The positive output signal from transistor Q8 produced when the counter goes from nine to zero, can be used to drive another Model 750A DCU. Thus, the counter will supply one input pulse to the next DCU for every ten counts registered.

The number of counts registered by the DCU is represented in binary-coded form by the potentials on the readout lines of the binaries. Since output signals are available from both sides of each binary, either the left-hand or the right-hand set of readout lines can be used for the coded signals. The choice depends only on whether the "one" state of each binary is to be represented by a low or a high potential.

The reset line is connected through a corresponding resistor to the base of the right-hand transistor in each binary. A negative voltage pulse applied to the reset line will therefore cause the right-hand transistors to conduct, and thus trigger all binaries to the zero state.

MODEL 750A DCU
SCHEMATIC DIAGRAM



REGISTERED COUNT	BINARY STATES 0=CONDUCTING 1=NOT CONDUCTING			
	Q2	Q4	Q6	Q8
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1

NOTE
1. RESISTORS:
   WATTAGE ____ 1/2W UNLESS OTHERWISE NOTED.
   TOLERANCE ____ 10% " " "
2. CAPACITORS:
   CAPACITY ____ IN μμf " " "
3. TRANSISTORS: 2N404.
4. DIODES: IN95 UNLESS OTHERWISE NOTED.

INSTRUCTION MANUAL

MODEL 751A

DECIMAL COUNT INDICATOR

Beckman/Berkeley Division
Richmond, California

April 1961

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Subject to the exceptions and upon the conditions specified below, the Company agrees to correct, either by repair, or, at its election, by replacement, any defect of material or workmanship which develops within one year after delivery of the instrument to the original purchaser by the Company or by an authorized representative, provided that investigation and factory inspection by the Company discloses that such defect developed under normal and proper use.

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All correspondence concerning the instrument should specify the model and serial number. This information appears on the company name plate. Any inquiry concerning details of operation, possible modifications, etc., should be addressed to the Sales Department, Berkeley division of Beckman Instruments, Inc., Richmond 4, California.

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Berkeley reserves the right to make changes in design at any time without incurring any obligation to modify equipment previously purchased to conform to subsequent design changes.

BERKELEY DIVISION
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INSTRUCTION MANUAL REVISION

Model 751A, lots 1 through 5.

Please note that most units in these lots differ slightly from the circuit shown in the schematic diagram. They do not have resistors R24, R25, and R26; in addition, R8, R9 and R10 are 6.8K.

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1. INTRODUCTION

1.1 GENERAL DESCRIPTION

The Model 751A Decimal Count Indicator is an electronic plug-in unit which provides a decimal digit display of the counts registered by a Decimal Counting Unit. Either Model 750A, 760, or 770 may be used. By means of a transistor matrix, the indicator unit converts each combination of binary-coded output signals from the DCU into the corresponding decimal digit, displayed as a lighted numeral.

Like the DCU's, the indicator unit is made up of solid-state components mounted on a printed circuit board.

1.2 TECHNICAL CHARACTERISTICS

Count Display

Illuminated decimal digits

Input

Binary-coded decimal signals from Model 750A, 760, or 770 DCU's.

Power Requirements

40 ma at -7.5 v. (±5%)

Construction

Printed card plug-in unit (with 15-pin printed circuit connector).

Dimensions

5/8 inch wide, 4-1/16 inches high, 4-3/8 inches deep

Weight

4-1/2 oz.

2. OPERATION

2.1 MOUNTING THE UNIT

The DCI can be mounted by plugging into a 15-pin printed-card connector. When plugged into a connector having lettered terminals, the unit should be inserted so that the line on the card labelled GND. corresponds to terminal S on the connector.

2.2 MAKING ELECTRICAL CONNECTIONS

To operate the Model 751A DCI, the connector terminals must be hooked up as indicated in Table I.

Table I. DCI Connector Hook-up

MODEL 751A PIN	SOURCE CONNECTION
B	-7.5 volt power supply
D	Pin D of Model 750A DCU connector
F	Pin F of Model 750A DCU connector
M	Pin M of Model 750A DCU connector
P	Pin P of Model 750A DCU connector
S	Ground

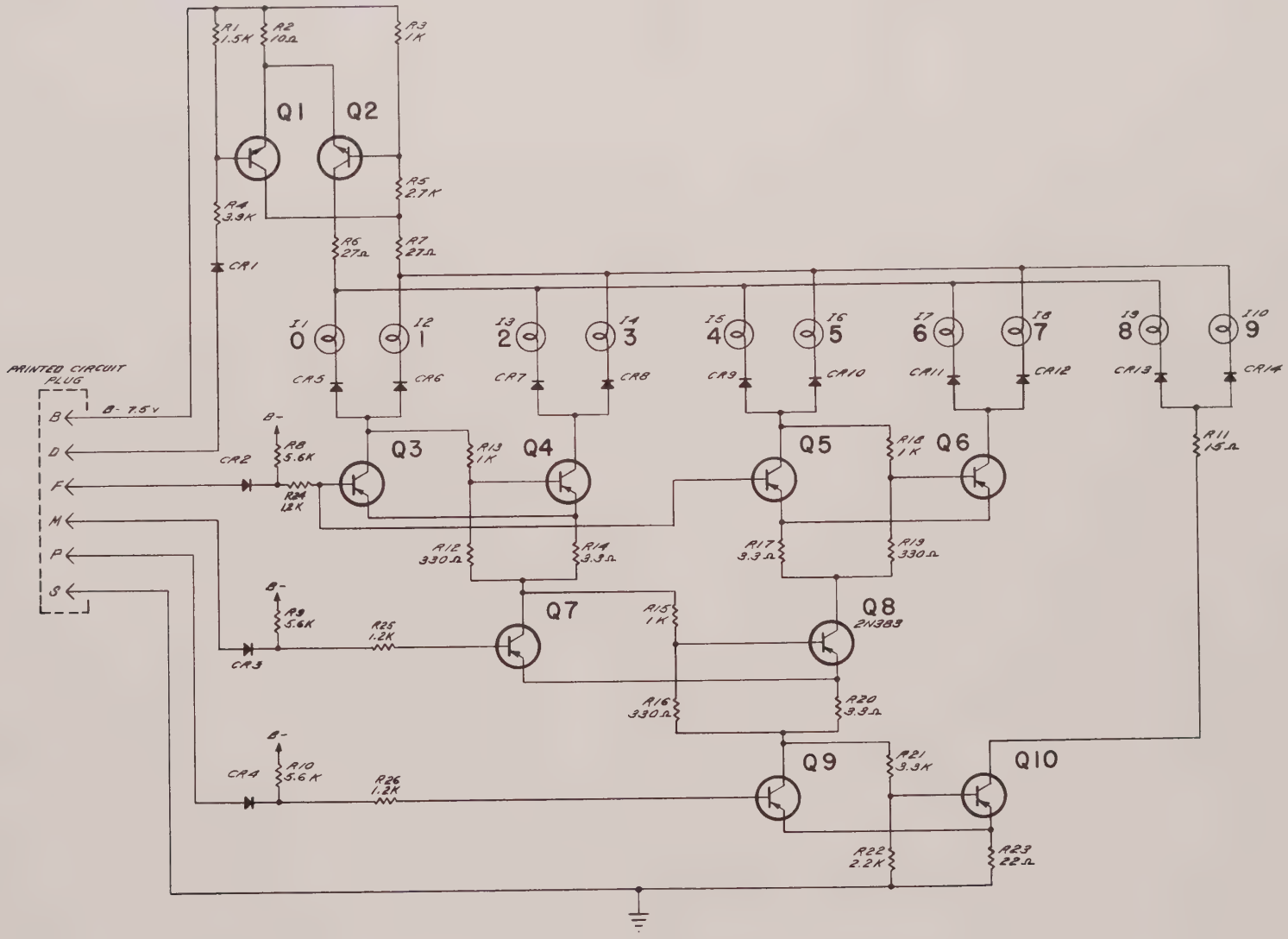
3. CIRCUIT DESCRIPTION

The indicator circuit consists of 10 indicator lamps, numbered from 0 to 9, connected in a transistor matrix. The matrix is made up of five pairs of transistors, each pair acting like a single-pole, double-throw switch. That is, current will flow through the one transistor in each pair which is able to conduct at any given time.

For each combination of potentials at the input terminals (D, F, M and P) there is one combination of conducting transistors. Each such combination provides a closed circuit path to the power source for only one indicator lamp. Furthermore, the indicator lamp thus energized will be the one whose number corresponds to the binary code represented by the input potentials. Thus, each count registered by the associated DCU will be indicated by the correspondingly numbered lamp of the DCI. Table II lists the transistors which should be conducting at each registered count.

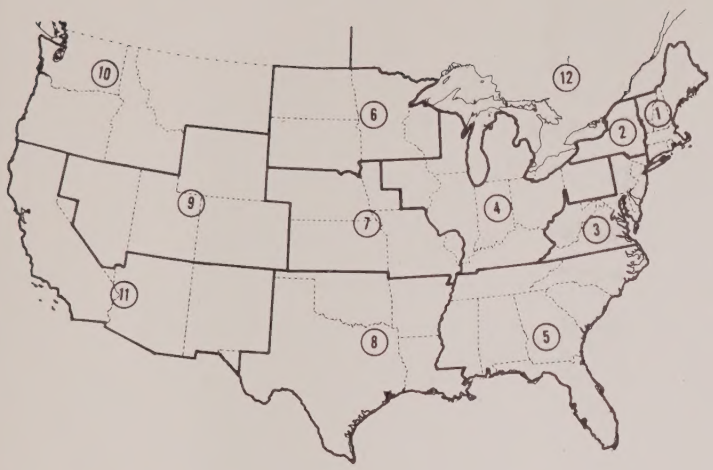
Table II. Circuit States

REGISTERED COUNT	TRANSISTORS CONDUCTING
0	Q2, Q3, Q7, Q9
1	Q1, Q3, Q7, Q9
2	Q2, Q4, Q7, Q9
3	Q1, Q4, Q7, Q9
4	Q2, Q5, Q8, Q9
5	Q1, Q5, Q8, Q9
6	Q2, Q6, Q8, Q9
7	Q1, Q6, Q8, Q9
8	Q2, Q10
9	Q1, Q10



NOTE:

1. RESISTORS:
   WATTAGE ——— ½ W EXCEPT AS NOTED.
   TOLERANCE ——— 10% " " "
2. INDICATING LAMPS, I1 TO I10 ARE GE-1779.
3. TRANSISTORS: Q1 & Q2 — TYPE 2N249
   Q3 THRU Q10 - BERKELEY PART NO. 8-8244 (2N1130 OR EQUIV.)
4. DIODES ARE BERKELEY PART NO. 8-8300 (1N95 SELECTED FOR 75 MA. FORWARD CURRENT AT 1 VOLT.).



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Detailed technical bulletins on all the equipment appearing in this catalog, as well as on similar equipment not shown, can be obtained from your nearest Beckman/Berkeley sales representative. He is also available for consultation and can offer valuable assistance in analyzing equipment needs and selecting instrumentation best suited to the job.

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